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ABSTRACT

Findings of a 1989 research study on LOGO-based instruction for teaching abstract concepts of geometry are reported in an effort to encourage mathematics teachers to use the LOGO language in computer-assisted instruction. Thirty-three ninth graders (19 males and 14 females) (6 white students and 27 black students) were involved in the controlled pretest-posttest study design. The experimental group was taught using lesson plans, LOGO programs, LOGO tutorial programs, student handouts, class activity sheets, homework sheets, and other teaching materials. The control group was taught using a textbook, formal lectures, and paper-and-pencil activities. Pretests and posttests involved Likert and semantic differential scales, and 13 students were interviewed. An analysis of covariance was applied using pretest scores as covariate variables and posttest scores as dependent variables. Results indicate that students receiving LOGO-based instruction performed better and developed more positive attitudes toward learning geometry. Findings are presented on teacher attitudes and student preferences regarding cooperative use of computers with other students. (TJH)

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LOGO BASED INSTRUCTION

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LOGO BASED INSTRUCTION

The objectives of this paper are: (i) to disseminate the findings of the research study conducted in 1989 on Logo Based Instruction for teaching abstract concepts of geometry, (ii) to encourage teachers for using Logo Computer Language as a tool in teaching geometry. The purposes of the research study were: (i) to find out the effects of Logo Based Instruction[1] (LBI) for teaching the geometric concepts of point, ray, line and line segment, (ii) to find out the effects of Logo Based Instruction on the students' attitudes towards geometry, Logo, and LBI.

The strongest claim about Logo computer language is that it has been designed as a learning environment. Logo is interactive, procedural, and extensible. Basing his ideas on constructivist philosophy of Piaget and information - processing psychology, Papert (1980) proposed that in Logo programming, children must reflect on how they might do the task themselves and, therefore, on how they themselves think. The Logo project stemmed to a large extent from the theory, rooted in artificial intelligence, that people learn from their mistakes. This debugging has been hypothesized to be central to all learning (Dehn & Sehank, 1982). In this theory, detected errors force shifts in attention to that which is important, altering memory organization and affecting future processing of similar situation. Hence, the environments of Logo computer programming holds the promise of being an effective device for developing cognitive and meta-cognitive skills.

In Logo programming children reflect on how they might do the task themselves, and therefore on how they themselves think. The child programs to teach the computer how to think. So the child embark on an exploration about how he himself thinks. Thinking about thinking turns the child into an epistemologist, an experience not even shared by most adults (Papert, 1980). People learn from their errors. According to Papert these errors engender rich social interactions on high intellectual level. In Logo, children solve self-selected problems, communicate their organizations of the task and solution processes to each other and to a machine, and analyze their thought processes for errors.

Majority of the Logo research studies supported the theory and philosophy of Papert (1980) while some Logo research studies produced conflicting results. There are other Logo research studies which produced mixed result i.e. they supported for some aspect while conflicted on other aspects. This situation has raised various issues around Logo such as Papert's claims for Logo potentials are real or illusionary. To my mind the important question is not about Papert's claims for Logo, instead the question is: Can we improve the quality of education by

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[1] Logo Based Instruction (abbreviated LBI) is defined as using Logo Computer Language Programs as a tool for instruction in addition to specified teaching methods and techniques. The researcher developed a lesson plan for the teacher and instructions for the students for each lesson.

using Logo as a tool for instruction? Hence the research study was designed for using Logo Computer Language as a tool for teaching geometry to 9th graders at Hughes High School Cincinnati, Ohio. True Quasi Experimental Design was used for the research experiment. An experimental group G_1 (14 males, 11 females; 20 black, 5 white) and a control group G_2 (5 males, 3 females; 7 black, 1 white) were selected. The total subjects were 33 (19 males, 14 females; 27 black, 6 white). The teacher T_1 taught the experimental group G_1 using Lesson Plans, Logo Programs, Logo Tutorial Programs[2], students' handouts, class activities sheets, homework sheets and other teaching materials, while the teacher T_2 taught the control group G_2 using the text book through lecture and paper and pencil activities. The content consisted of points, rays, lines, and line segments was covered in the research experiment which was completed in two weeks.

Pre-test was administered before the experiment and parallel post-test was administered after the experiment. Likert Scales and Semantic Differential Scales were administered at the beginning and at the end of the experiment. Interviews of 13 students (8 from G_1 2 male, 6 female; 6 black, 2 white and 5 from G_2 3 male, 2 female; 4 black, 1 white) and both of the teachers involved were conducted at the end of the experiment.

Analysis of Covariance (ANCOVA) was applied using pre-test scores (X_1, X_2) as covariate and post-test scores (Y_1, Y_2) as dependent variable. The difference between the post-test and the pre-test scores was significant at alpha = .001 $p < .001$ to reject the null hypothesis. Please see the TABLE A.

TABLE A: ANCOVA

SOURCE	SS′	V	MS′	F
Between	198.01	1	198.01	15.35
Within	386.95	30*	12.90	
	584.96	31		

$_{.95}F_{1,30}$ = 4.17, $p < .05$

$_{.999}F_{1,30}$ = 13.30, $p < .001$

* $V_e = n_{..} - J - c$ (# of covariates)

$= 33 - 2 - 1 = 30$

Attitude points on the Likert Scales and Semantic

[2] The researcher developed all the Logo Programs using the software Apple II LOGO on the hardware Apple II e.

Differential Scales were calculated by multiplying total frequencies under the points 5, 4, 3, 2, and 1 by 2, 1, 0, -1, -2 respectively if the statement was positive and by -2, -1, 0, 1, 2 respectively if the statement was negative. The sum was divided by the number of subjects to find out the average attitude points for geometry, Logo and Logo Based Instruction.

From the analyses of the data the following findings and conclusions could be drawn:

1. High school students taught the geometry concepts of point, ray, line and line segment with Logo Based Instruction programs scored significantly higher ($p < .001$) than students taught the same concepts by teacher lecture, and paper and pencil activities.

2. High School students taught the geometry with Logo Based Instruction showed more positive attitude (+0.28 average points higher) towards learning geometry than students experiencing more traditional pencil and paper approach as compared by Likert Scale and also showed more positive attitude (+5.11 average points higher) when compared by Semantic Differential.

3. High school students experiencing learning with Logo Based Instruction exhibited positive attitudes towards learning LOGO (+0.88 average points higher) and towards learning with Logo Based Instruction (+4.24 average points higher) as compared by Likert Scale and also exhibited positive attitudes towards learning Logo (+7.11 average points higher) and towards learning with Logo Based Instruction (+1.71 average points higher) when compared by Semantic Differential..

4. Providing Logo programs specifically prepared for the lessons, class activities sheets, home work sheets, hand outs and other teaching material such as branches of trees, thread, bottle of sugar etc., explaining with figures, definitions in boxes, and providing summaries while using Logo computer language as a tool for teaching and learning geometry at high school level were found effective methods and techniques for whole class instruction.

5. Most of the exercises provided in the class activities were found interesting, thoughtful and effective while some of them were difficult and above the level of the students.

6. Most of the students (92.3%) from the both groups (G_1 & G_2) liked to use a computer for learning geometry and the both teachers (T_1 and T_2) liked to use computer for teaching geometry.

7. Most of the students (62.5%) form the experimental group and some students (40%) from the control group preferred (at the time of interview) to use Logo Computer Language for learning geometry giving the following reasons: (i) Its a natural choice for learning geometry (ii) Its an easy computer language (iii) Its a powerful computer language (iv) It sound better. The teacher (T_1) of the experimental group considered Logo Computer Language as a natural choice for teaching geometry while the teacher (T_2) of control group said, "no idea" because he did not know any computer language.

8. Half of the students from the experimental group and some of the students (20%) from the control group liked to use the computer <u>with another student</u> while some students (25%) from the experimental group and most of the student (80%) from the control group liked to use the computer <u>alone</u>. Both of the teachers (T_1 & T_2) liked to have one computer for each student for teaching geometry effectively and efficiently.

9. All the students from the experimental group and most of the students (60% from the control group thought that a large monitor or other projection device should be available for the teacher to teach geometry effectively and efficiently. The teacher (T_1) of the experimental group did not consider, a large monitor or other projection device, necessary for teaching geometry effectively and efficiently while the teacher (T_2) of the control group thought that a large monitor or other projection device should be available for the teacher for teaching geometry effectively and efficiently.

10. All the students from the experimental group and most of the students from the control group (60%) considered that Apple computer was suitable hardware to learn geometry. The teacher (T_1) of the experimental group considered Apple as suitable hardware to teach geometry because it was available while the teacher (T_2) of the control group had no idea.

11. Most of the students (75%) from the experimental group liked to use Logo programs specifically prepared for the topics for whole class instruction. The teacher (T_1) of the experimental group liked to provide individual instruction using drill and practice programs, simulation programs, programs specifically prepared for the topics for whole class instruction and tutorial programs while the teacher (T_2) of the control

group had no idea.

12. The students of the experimental group provided the following comments about the Logo Programing Exercise and Logo Tutorial Programs:

i) Logo programs helped to learn abstract concepts of geometry better than the books.
ii) Logo programs helped them to learn geometry.
iii) Logo programs made it easy to learn geometry.
iv) Logo programs were useful for revision.
v) Logo programs provided visible activities to learn abstract concepts in geometry.
vi) Logo programs made it fun to learn geometry.
vii) Logo programs were O.K..
viii) Logo programs were good.
ix) Logo programs were good but hard.
x) Logo programs were interesting.
xi) I like them.

All the students of the control group did not comment on Logo Programs (because they were not taught through them) except one who said, "I would like to learn how to use them".

13) The comments of the teacher (T_1) of the experimental group could be summarized as follows:

He appreciated the combination of the use of computer with other teaching materials for teaching abstract concepts of geometry. He also liked the variety of instruction in the research experiment. He liked the handouts explaining the methods and techniques of instruction, handouts providing instruction to the students, class activities and home work sheets. He appreciated the use of different colors for the teacher's handout (white), the students' handouts (green), class activities sheets (yellow) and home work sheets (pink). He liked the use of figures, boxes and summaries in the students handouts. He pointed out that some class activities were hard, difficult and above the academic level of the students and there was no time to provide practice for logo procedures. According to his opinion all the students of the experimental group showed positive attitude towards Logo Based Instruction.

14. The recommendations, for the next research experiment, provided by the teachers (T_1 & T_2) could be summarized as follows:

i) The next research experiment should be conducted in the first or second quarter of 1989-90 school year.
ii) The research experiment should be conducted

in two weeks.

iii) the content topics should be tied with the school syllabus.

iv) The concerned teachers should be contacted as early as possible for the smooth running of the experiment.

v) Teachers trained in computer should be selected for the experiment.

15. Logo computer programs specifically prepared for the topics for whole class instruction, Logo Tutorial Programs, Logo Computer Language, teaching material such as branches of trees, thread, bottle of sugar etc., handouts for the teacher, handouts for the students, summaries, definition in the boxes, figures, class activity sheets and home work sheets were found effective methods and techniques for teaching and learning geometry at high school level.

DISCUSSION

Both the teachers (T_1 & T_2) were in the view that 4th quarter was not good time for the research experiment because most of the students knew their results for the academic year 1988-89 and were sure that they had passed the grade level, hence many of them were neither serious nor interested in their studies. So the teachers were not expecting the regular attendance. Their expectation were fulfilled during the research experiment because from G_1 only 25 students out of 37 enrolled, took both the pretest and the post-test while from G_2 only 8 out of 23 enrolled, took both the pretest and the post-test. Due to the above mentioned reason the control group sample was only 8 subjects. Although the total registered students for the class were 23 but only 8 students were attending the class regularly. The second reason could be the population of the school. Most of the students of Hughes High School were low S.E.S (Socioeconomic Status), black, average and below average students. However, there were following advantages for the selection of Hughes High School: (i) the computer laboratories were well equipped, (ii) it was near University of Cincinnati, hence the access to the school was easier and (iii) most of the students were average and below average, therefore, it was thought that if LBI (Logo Based Instruction) would work in the school then it would probably work in other schools also.

Lesson plans provided in the teacher's handouts worked very well. The instructional management chart was modified with consultation of the both teachers to provide one day for revision before the post-test. First pre-test then Likert scales and Semantic Differential Scales were administered before the research experiment while first post-test then Likert Scales and Semantic Differential Scales were administered after the research experiment in both experimental and control groups. Administration of the tests before the Likert Scales and

Differential Scales might have affected the attitudes of the subjects as it could be concluded from the results against the statement "I usually don't expect to get good grades in geometry" where attitudes points decreased from +15 to -1 in the experimental group and +8 to +2 in the control group.

The students random sample for the interviews was not representative according to the sex, because Male, female ratio for the sample of the research study was 19:14 while the ratio for the interviews random sample was 5:8. Hence during the next research experiment sexwise random sample should be selected for the students' interviews.

The mean score for G_1 was 4.68 and for G_2 was 11.16 on the pre-test, hence G_1 was not equivalent to G_2, therefore, t-test could not be applied. It was appropriate to apply Analysis of Covariance (ANCOVA) using pretest scores (X_1, X_2) as covariate and post-test scores (Y_1, Y_2) as dependent variable. The null hypothesis was rejected at alpha = 0.001 ($F = 15.35$ $_{.999}F_{1,30} = 13.30$ $p < .001$). Hence it was found that 9th/10th graders taught the geometry concepts of point, ray, line and line segment with the LBI programs scored significantly higher on the researcher made test than the 9th/10th graders taught the same concepts through normal school routine.

Likert Scales and Semantic Differential Scales were used to calculate average attitude points. The experimental and the control groups were compared in term of gain in average attitude points. The gain in average attitude points might not be the test of significant change in attitude, however, it did indicate the direction of the attitude change. From the average attitude points on Likert Scales and Semantic Differential Scales, it could be concluded that the high school students taught the geometry with LBI programs showed more positive attitudes towards geometry, Logo, and learning with Logo Based Instruction than the students experiencing more traditional paper and pencil approach.

From the interviews of the students and the teachers, it was evident that the students of the experimental group exhibited more positive attitude towards (i) learning abstract concept of geometry (ii) learning Logo and (iii) learning with Logo Based Instruction.

The use of Logo computer language, Logo programs specifically prepared for the topics for whole class instruction, Logo Tutorial Programs, teaching materials such as branches of trees, thread, bottle of sugar, handouts for the teachers, handouts for the students, summaries, definitions in boxes, providing summaries, explaining with figures, class activities sheets and home work sheets were found effective methods and techniques for teaching and learning geometry to 9th graders.

The Logo Based Instruction programs were found significantly effective for the students' achievement in geometry. The LBI programs were also effective to bring positive change in attitude toward geometry, Logo and Logo Based Instruction. It is important to note that the most of the students were black, from

low socioeconomic status, and were blow average on the national norm. The experimental group teacher was white while the control group teacher was black. The teachers' enthusiasm and other variables might have also affected the results. Therefore, further research studies should be conducted at different locations to find out the effects of LBI for teaching geometry at high school level. However the results are encouraging for teaching geometry through LBI to 9th/10th graders. Hence the teachers are encouraged for using Logo Computer Language as a tool in teaching geometry.

As the computer has been recently introduced in the secondary school classroom so it can be utilized effectively for improving achievement in geometry. LBI is one way of using computer in the classroom. The logo computer language is appropriate for teaching and learning geometry. We must take full advantage of Logo Computer Language to improve the results in geometry.

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